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NINTH BI-MONTHLY PROGRESS REPORT
 UNIVERSITY OF ALASKA
 ERTS PROJECT NO. 110-2
 FEBRUARY 6, 1974

UR-136677

A. TITLE OF INVESTIGATION: Identification of Phenological Stages and Vegetative Types for Land Use Classification

B. PRINCIPAL INVESTIGATOR/GSFC ID: Jay D. McKendrick/UN 641

C. PROBLEMS IMPEDING INVESTIGATION:

A serious limitation slowing our progress is the inoperative CDU. In view of our contract expiration date (February 13, 1974) and the current inoperative condition of the CDU we expect to obtain for this project no more digital displays, other than the three already obtained.

D. PROGRESS REPORT:

1. Accomplishments during reporting period.

This is our last bi-monthly report due to the pending expiration of the contract. Therefore, the final report will include maps and illustrations of our findings. We wish to stress that MSS signature data contained in this report have not been applied beyond the original training sets, i.e. used to classify MSS data. These refined signatures and those being derived and refined between now and February 13, 1974 will probably be verified via methods other than the CDU for inclusion in the final report.

Selected ground truth areas from NASA aircraft data were mapped on plastic overlays to the scale of digital printouts for 13 CDU scenes via the Bausch and Lomb Zoom Transfer Scope. Those overlays were needed to locate training sets for MSS signature extractions. Due to the lack of man-made features on most of the Alaskan landscape, it is extremely difficult to precisely locate training sets in specific vegetation types without the aid of the Zoom Transfer Scope. Also confounding the problem is the varied nature of the Alaskan vegetation. In order to overcome our uncertainty in extracting signatures we have statistically analyzed the signature variation within

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(E74-10290) IDENTIFICATION OF
 PHENOLOGICAL STAGES AND VEGETATIVE TYPES
 FOR LAND USE CLASSIFICATION Bimonthly
 Progress Report (Alaska Univ., Palmer.)
 17 p HC \$3.00

bands and vegetation types and developed minimum sample size requirements (Table 1). The assumptions for our model are the standard statistical analysis assumptions: (1) pixel intensities within training sets are normally distributed about the mean, (2) our selection of test areas was random with types and (3) by adequately sampling for a 99% confidence of the true mean of the population of intensities, we would obtain an adequate estimate of the population parameters of pixel intensities. To insure adequate sampling error protection the final sample size was computed to the next highest multiple of 6 because training sets must include an equal number of samples from each of the 6 scanners to balance interscanner errors.

Based on those training set intensity samples we developed MSS signatures for automated classification of the features which are useful for identifying locations having agricultural potential (Table 2) and other commercial interests. Water signatures must be included because water features serve as reliable geographical location references.

Signature refinement was essential for distinction among features. Also due to the MSS data overlap in birch-spruce and scrubby spruce, signatures for those two types were combined. That overlap probably resulted from a large inherent variability within the deciduous-coniferous mixtures. In addition to the value of these classifications to crop land and grazing land enterprises, the possibility of identifying commercial cottonwood and commercial spruce stands in ERTS-1 data is of particular value to the U.S. Forest Service, Bureau of Land Management, the State of Alaska and the Alaskan native corporations. The highest probability of identifying commercial stands of timber was calculated to be about 80-82% (Table 3). The vastness of the Alaskan forest and paucity of timber volume estimates would appear to impel urgent consideration of automated means for obtaining those estimates. The 80% accuracy in automated classification of commercial stands would have an

economical advantage of at least an order of magnitude over the costly aircraft and relatively slow visual interpretation methods,

Statistical analyses of features' signatures within and among MSS bands showed certain peculiarities (Tables 4, 5, 6 and 7) which indicated the probable value of data transformation to improve automated classification potentials. Bands 4 and 5 are quite "flat", i.e. the signature variances are low. The treeless bog and muskeg types (definitely poor agricultural sites) had skewed distributions of intensities in band 4, i.e. the median, mean and mode were relatively distant from each other compared to those respective parameters for other vegetation types. That probably reflects dissimilarities within our grouping of types and may indicate they possibly could be separated in data obtained during another season of the year.

The birch-spruce and scrub-type signatures in band 4 had a broad variance, reflecting the above-mentioned problem resulting from combining signatures among types. Within this classification type occurs lands with agricultural potential where topography and soil depth permits. Therefore, identifying this type is important to our project objectives related to agriculture.

Although band 5 was considered relatively "flat" as compared to bands 6 and 7, the signature variances in band 5 are larger than those in band 4, and the signatures appear to have relatively normal distributions, except for the clear water signature. The clear water signature may be showing the effects of an edge-effect in shallow lakes and/or inadequate sampling since this particular CDU scene contained few lakes large enough to sample.

Signatures in band 6 consistently contained the largest variation compared to those of the other bands. However, data in band 6 are important for separating commercial white spruce from scrubby spruce, a capability valuable to forestry interests in Alaska.

Signatures in band 7 as a rule were distributed normally with the exception of the aforementioned clear water, a slight skewness in the birch-spruce

and scrub combination and the commercial spruce signature, However, those characteristics did not significantly reduce the respective classification accuracies as much as those in band 6 (Table 3),

Two color digital imagery samples have been processed by the Dicomed Corporation of Minneapolis. Their service was found to be very good and quite valuable to our project objectives. In our final report we expect to include quantitative evaluation of that process compared to optically enlarged color imagery.

To assist our mapping efforts, Mr. Peter C. Scorup visited the U.S. Geological Survey Cartographic Division in Denver, Colorado, while in that state on personal business. We compared their methods to those of the Soil Conservation Service in Portland, Oregon and explored the possibility of using U.S.G.S. plates containing township and range lines and topographic contours in conjunction with our vegetation themes.

In our continuing efforts to educate local people about ERTS, we have recently guided three high-school age groups (about 50 students) through our Palmer facility. Following the tours, the high school teacher expressed great interest in our work and indicated that he intended to incorporate our lab into his field trip plans for his future earth science classes. Other visitors included Alaska's State Senator Jalmar Kerttula and William Lewis, Director of the Alaska State Division of Agriculture. Both Senator Kerttula and Mr. Lewis expressed interest in our project, a willingness to support our expansion efforts, and stated that current and future results from ERTS would be of great value not only to Alaskan residents but also to others with interests in Alaska. The Alaska Rural Development Council, an organization composed of state, federal and private groups with interests in agriculture, was presented with a report on our project. As a result of that report, the council passed a resolution favoring the continuation of our work (see appendix).

F. PUBLICATIONS;

(a) In preparation;

McKendrick, Jay D. and Peter C. Scorup. 1974. From ERTS-1--A Super Bird's-Eye View of Alaska, *Agroborealis* 6(1):_____. (see attached manuscript).

(b) In Press: None

(c) Published:

McKendrick, Jay D. 1973, Mapping Alaskan Vegetation from ERTS-1 Data. A report to the Alaska Rural Development Council. December 6, 1973 Anchorage, Alaska (xerox). (see previous report for copy).

G. RECOMMENDATIONS: None

H. CHANGES IN STANDING ORDER FORMS: None

I. ERTS IMAGE DESCRIPTORS FORMS: (see attached appendix)

J. DATA REQUEST FORMS: None

TABLE 1. Number of picels required for an adequate sample ($d=2$ and $P < 0.01$)^{*} of digital data training sets in ERTS-1 MSS CCT data for each of eight features in scene 1033-21011.

FEATURE	-----BANDS-----				MINIMUM SIZE OF TRAINING SET
	4	5	6	7	
Commercial cottonwood	4	3	26	7	30
Birch & aspen	5	5	92	14	96
Tall shrub	4	4	25	13	30
Muskeg & treeless bogs	39	8	35	11	42
Birch-spruce & scrub	71	8	71	35	72
Commercial spruce	3	7	43	20	48
Clear water	4	8	28	12	30
Silty water	7	15	6	3	18

^{*/} d = confidence interval; P = probability level

TABLE 2. Observed (o) and refined (R) MSS signatures for eight features in training sets from CCT data ERTS-1 scene 1033-21011.

FEATURE	-----MSS BANDS-----							
	4		5		6		7	
	o	R	o	R	o	R	o	R
Commercial cottonwood	14-17	14-17	8-10	8-10	22-29	22-29	13-17	15-17
Deciduous forest	14-18	14-18	7-11	7-10	30-40	30-40	18-27	18-27
Tall shrub	16-19	16-19	10-13	11-13	27-37	27-37	16-22	17-22
Treeless bog	15-39	15-21	9-15	11-15	20-31	24-31	11-18	11-16
Scrub & birch-spruce mix	14-18	14-18	7-12	7-12	14-30	16-23	7-19	9-14
Commercial spruce	13-17	13-17	6-10	6-10	10-26	11-15	4-15	6-15
Silty water	28-32	28-32	25-31	25-31	21-25	21-25	5-8	5-8
Clear water	14-16	14-16	6-9	6-9	7-14	7-14	2-7	0-5

TABLE 3. Percentages of data remaining after refinement of MSS signatures in training sets of eight features (ERTS-1 scene 1033-21011 CCT digital data) and calculated classification limits.

FEATURES	-----MSS BANDS-----				CALCULATED CLASSIFICATION ACCURACY LIMITS	
	4	5	6	7	MAX	MIN
Commercial cottonwood	100	100	100	82	82	82
Deciduous forest	97	100	100	100	97	97
Tall shrub	81	100	100	93	81	75
Muskegs & treeless bogs	96	100	94	93	93	87
Scrub & birch-spruce	100	100	83	80	83	66
Commercial spruce	100	100	85	89	85	76
Silty water	100	100	100	100	100	100
Clear water	100	100	100	93	100	93

TABLE 4. Radiation-intensity median, mean, mode, variance and coefficient of variation for band 4 signatures of eight features in MSS digital data (ERTS-1 scene 1033-21011).

FEATURES	MEDIAN	MEAN	MODE	VARIANCE	COEFFICIENT OF VARIATION
Commercial cottonwood	15.5	15.8	16	.69	4.36
Deciduous forest	16.0	16.1	16	.85	1.76
Tall shrub	17.5	17.2	17	.72	4.19
Treeless bog	27.0	18.7	17	2.42	12.97
Birch-spruce & scrub	15.5	16.2	17	3.27	20.22
Commercial spruce	15.0	14.8	14	.91	6.11
Silty water	30.0	30.2	30	.98	3.24
Clear water	15.0	14.7	15	.70	4.77

TABLE 5. Radiation-intensity median, mean, mode, variance and coefficient of variation for band 5 signatures of eight features in MSS digital data (ERTS-1 scene 1033-21011).

FEATURES	MEDIAN	MEAN	MODE	VARIANCE	COEFFICIENT VARIATION
Commercial cottonwood	9.0	9.4	10	.61	6.47
Deciduous forest	9.0	9.1	9	.82	8.96
Tall shrub	11.5	11.3	11	.76	6.77
Treeless bog	11.0	12.0	12	1.07	8.89
Birch-spruce & scrub	9.5	9.8	10	1.07	10.87
Commercial spruce	8.0	8.3	8	.98	11.79
Silty water	28.0	28.2	29	1.49	5.28
Clear water	7.5	8.1	9	1.06	13.03

TABLE 6. Radiation-intensity median, mean, mode, variance and coefficient of variation for band 6 signatures of eight features in MSS digital data (ERTS-1 scene 1033-21011).

FEATURES	MEDIAN	MEAN	MODE	VARIANCE	COEFFICIENT VARIATION
Commercial cottonwood	25.5	25.6	26	1.96	7.64
Deciduous forest	35.0	34.2	35	3.72	10.87
Tall shrub	31.5	30.6	30	1.91	6.25
Treeless bog	26.0	26.7	28	2.30	8.61
Birch-spruce & scrub	21.5	20.6	19	3.26	15.78
Commercial spruce	18.5	13.4	12	2.53	18.89
Silty water	23.0	22.8	22	.89	3.89
Clear water	10.5	10.3	10-11	2.05	19.98

TABLE 7. Radiation-intensity median, mean, mode, variance and coefficient of variation for band 7 signatures of eight features in MSS digital data (ERTS-1 scene 1033-21011).

FEATURES	MEDIAN	MEAN	MODE	VARIANCE	COEFFICIENT VARIATION
Commercial cottonwood	15.0	15.4	16	.97	6.30
Deciduous forest	22.5	22.1	22	1.43	6.48
Tall shrub	19.0	18.3	18	1.37	7.49
Treeless bog	14.5	14.8	15	1.28	8.65
Birch-spruce & scrub	13.0	11.3	10	2.28	20.16
Commercial spruce	9.5	6.8	7	1.70	24.95
Silty water	6.5	6.4	6	.67	10.46
Clear water	4.5	4.0	4	1.31	32.72

APPENDIX

NINTH BI-MONTHLY PROGRESS REPORT
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ERTS PROJECT NO. 110-2
FEBRUARY 6, 1974

PRINCIPAL INVESTIGATOR: Jay D. McKendrick

TITLE OF INVESTIGATION: Identification of Phenological Stages and
Vegetative Types for Land Use Classification

DISCIPLINE: Agriculture/Forestry/Range Resources

SUBDISCIPLINE: Range Survey and Classification

SUMMARY OF SIGNIFICANT RESULTS:

Recent signature identification and refinement techniques indicate that with automated classification of MSS CCT data commercial stands of cottonwood and white spruce can be identified with 80% accuracy in the Bonanza Creek experimental forest. Since that forest is a representative of the vast interior Alaska forests, this finding has substantial economic importance to public and private forestry interests in Alaska.

UNIVERSITY OF ALASKA

ALASKA RURAL DEVELOPMENT COUNCIL RESOLUTION - 12/6/73

Mapping Alaskan Vegetation From ERTS

WHEREAS, ERTS I projects have developed considerable expertise in vegetative mapping as well as other valuable geographic features and

WHEREAS, this mapping could be done in a more rapid, accurate and economical manner than any developed so far and

WHEREAS, the information that could be generated by this program would be of great value in planning the state's development, especially in rural and remote areas and

WHEREAS, many agencies, state, federal, borough, Native and private would use the information generated,

LET it be resolved that NASA be requested to give high priority to the follow-on and expansion of this project and

LET it be further resolved that the federal delegation be requested to lend their support to the follow-on project and

LET it further be resolved that agencies that would be potential users of this information be encouraged to express their need for the information and possible support and cooperation in the project.

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

DATE January 3, 1974PRINCIPAL INVESTIGATOR Dr. J. D. McKendrickGSFC UN-641ORGANIZATION University of Alaska 110-02

NDPF USE ONLY

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N _____

ID _____

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*				DESCRIPTORS
	RIVER	GLACIER	LAKE	MTS.	
1422-20212	✓	✓		✓	Valley
1426-20441	✓	✓	✓	✓	Matanuska Valley
1426-20444	✓	✓	✓	✓	Kenai Peninsula
1428-20551	✓	✓	✓	✓	
1428-20554	✓	✓	✓	✓	
1428-20560	✓	✓	✓	✓	
1422-20215	✓	✓	✓	✓	
1446-20553	✓	✓	✓	✓	
1446-20551	✓	✓	✓	✓	
1459-20260	✓	✓		✓	Valley
1461-20364	✓		✓	✓	
1462-20423	✓		✓	✓	
1463-20481	✓		✓	✓	Urban area (Fbks)
1465-21000	✓	✓	✓	✓	
1467-21104	✓		✓	✓	

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMNS).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-992-5405

ORGANIZATION University of Alaska 110-02

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GSFC 37-2 (7/72)